A Bayesian approach for parameter identification in elastoplasticity

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In computational mechanics, approaches based on error minimisation (e.g. the least squares method), are frequently used to identify material parameters based on experimental data [1]. An alternative approach is Bayesian inference which gives a probabilistic estimation of material parameters. Bayesian inference results in a probability density function (PDF), a so-called posterior distribution, which is a function of the material parameters of interest. The statistical properties of the material parameters, e.g. the mean values of material parameters, the material properties at which the PDF is maximum and the standard deviation, can be obtained by analysing the posterior distribution [2, 3].

Based on literature, it may not be obvious how to employ Bayesian inference for parameter identification of elastoplastic models, if one is only familiar with identification procedures based on error minimisation. In the field of computational mechanics furthermore, no studies have focused on the incorporation of errors in stresses, as well as in strains.

The current work aims to present how Bayesian inference can be employed to identify elastoplastic material parameters. To make the procedure as approachable as possible, all examples deal with a single spring. Special attention is paid to: (a) how to split the purely elastic and elastoplastic part of the response, (b) how to incorporate uncertainties in stress, as well as in strains, and (c) a number of misconceptions about Bayesian inference, that may not be straightforward for researchers only familiar with error minimisation based identification.

References

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